



Challenges and Lessons in High Speed Railway Planning in Denmark

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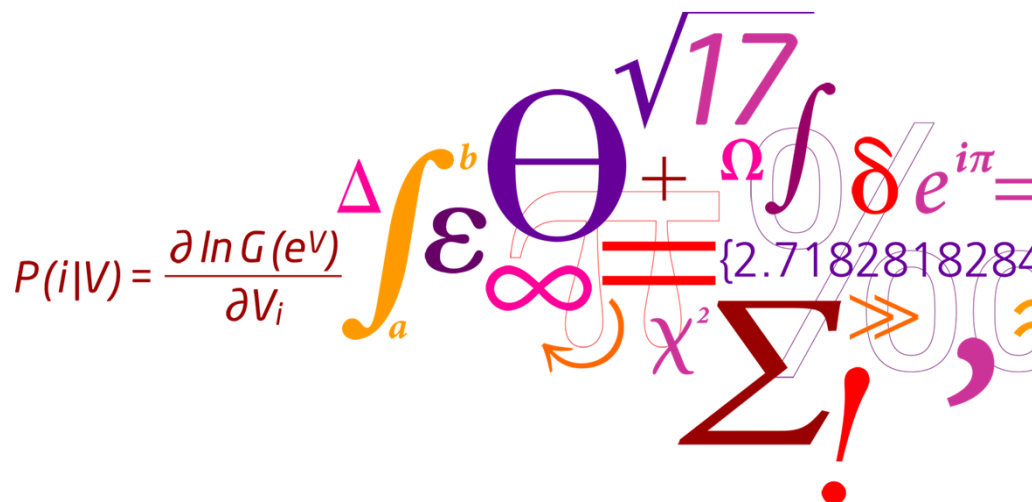
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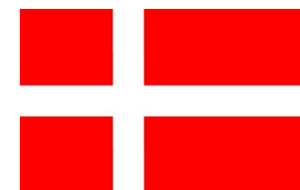
Challenges and Lessons in High Speed Railway Planning in Denmark

International Workshop on High-Speed Rail Planning and Operations 2015, Washington DC

Dr. Steven Harrod

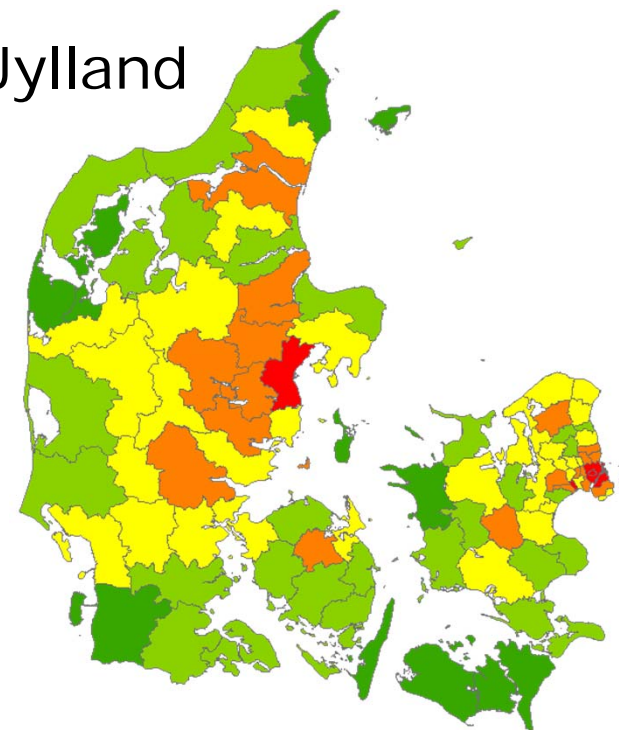
Technical University of Denmark





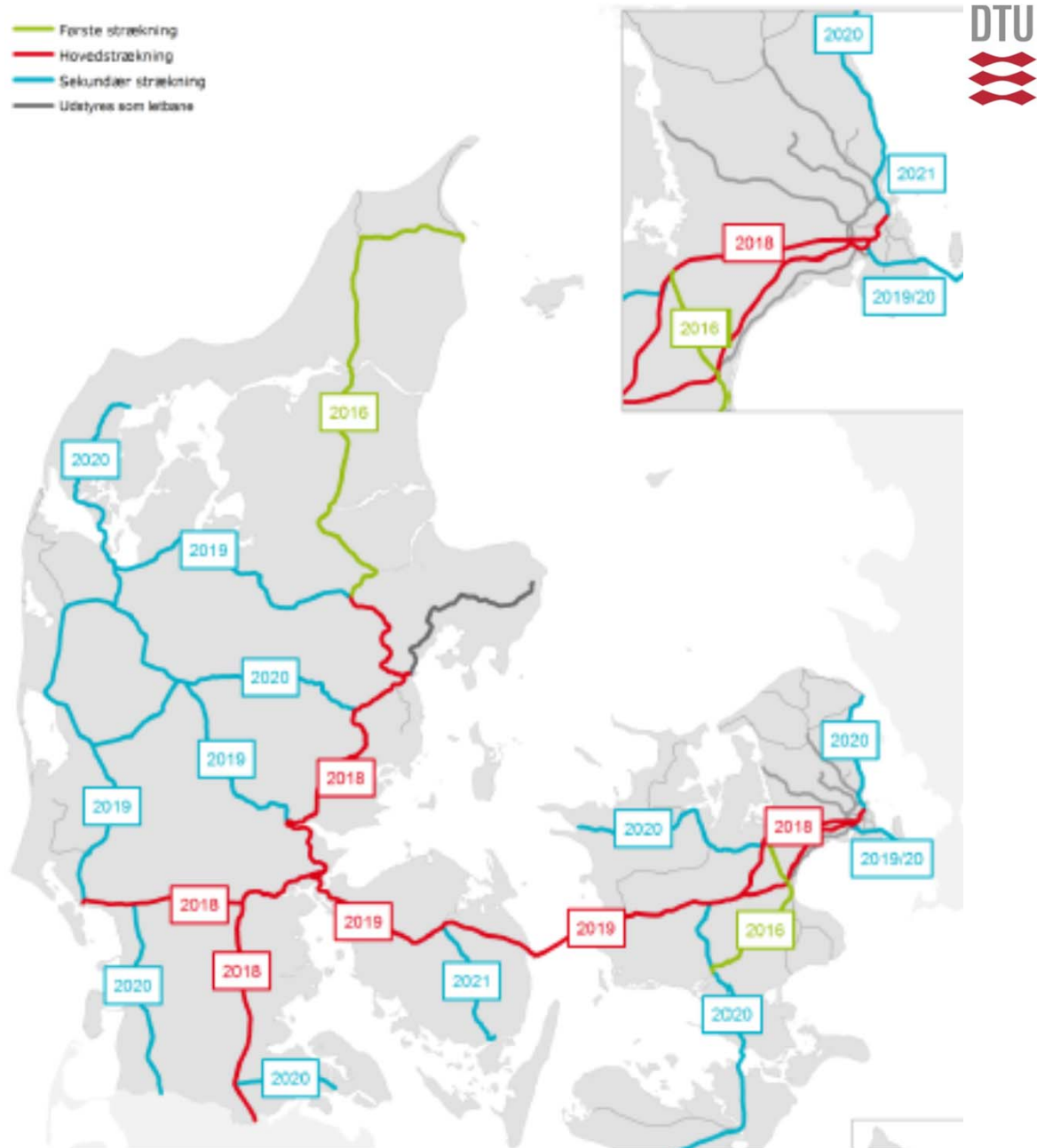
Danish Strategic Rail Plan

- U.S. \$1.5 Billion*
 - Copenhagen-Ringsted
 - Nearly complete, official opening 2018
- U.S. \$5 Billion
 - High Speed Alignment for Fyn & Jylland
 - European Signal Standard
 - Electrification
- U.S. \$6.9 Billion
 - Femern Bælt-forbindelsen
Femern Belt Link
 - Copenhagen-Rødby-Hamburg
 - Ferry replacement



New Signals

- ERTMS level 2
- Entirely cab signalled
- No wayside signals
- CBTC for Copenhagen suburban trains



Electrification

25k v, 50Hz



(15k v, 16.3Hz, Sweden & Germany)

Femern Bælt Forbindelsen



Strategic High Speed Rail Planning in Denmark

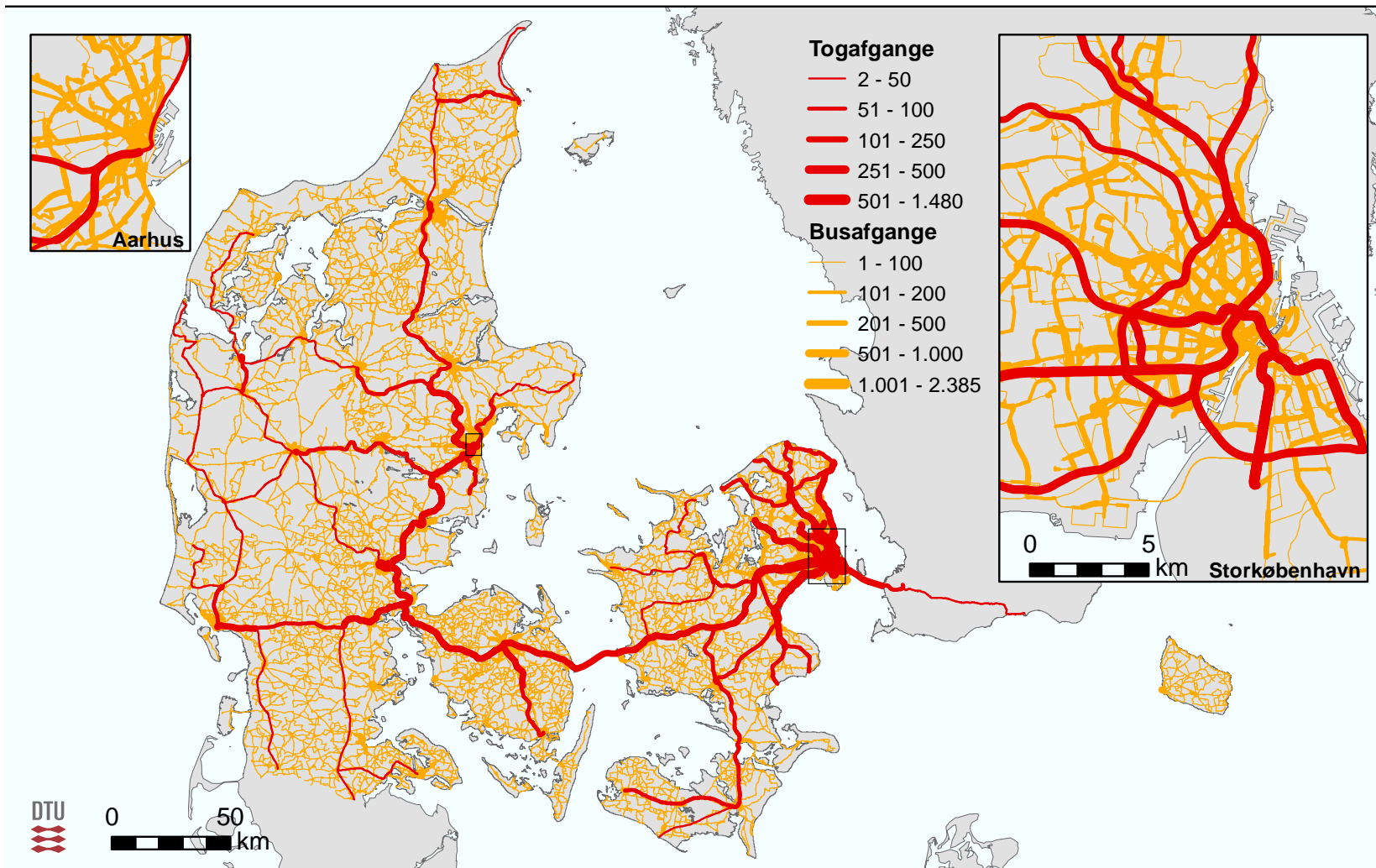
- The Danish Network Today
- Significant High Speed Projects
- Focus on the Whole Journey
- The Planning Process
- Future Forecast

A Familiar Scenario

- Network Originates from 1850-1880
- Primarily to Connect Port Cities
- Largely Unchanged Since 1940



Danish Public Transit



The Hour Model

Travel Times Today:

Copenhagen-Odense, 75 min.

Copenhagen-Aarhus, 170 min.

Copenhagen-Aalborg, 259 min.

Percent Reduction Required:

Copenhagen-Odense, 20%

Odense-Aarhus, 37%

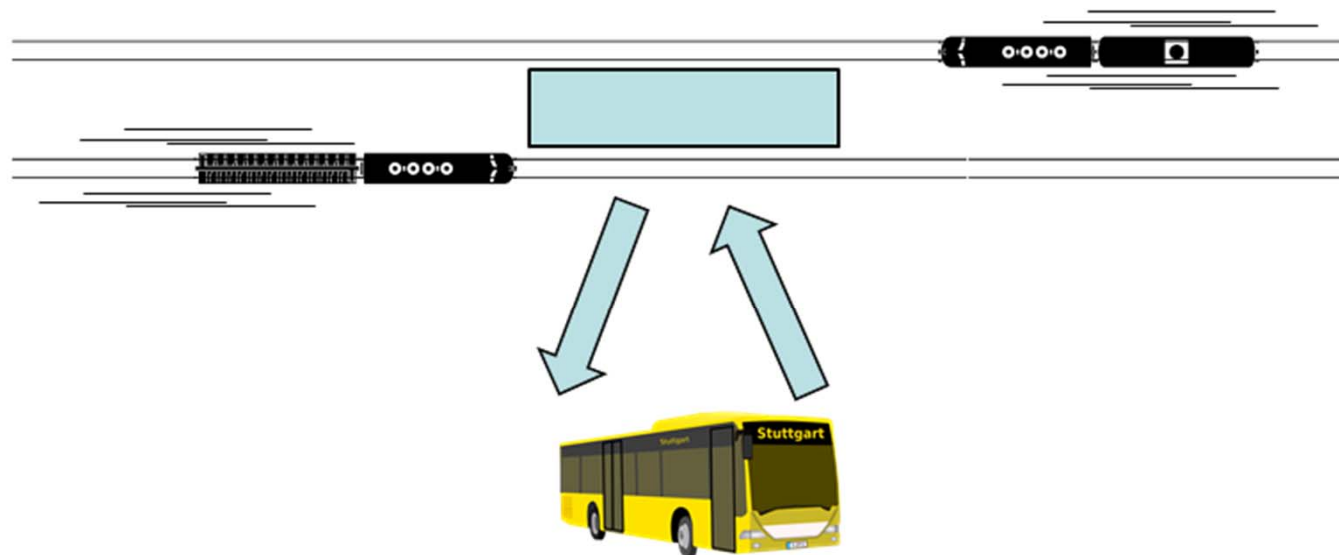
Aarhus-Aalborg, 33%

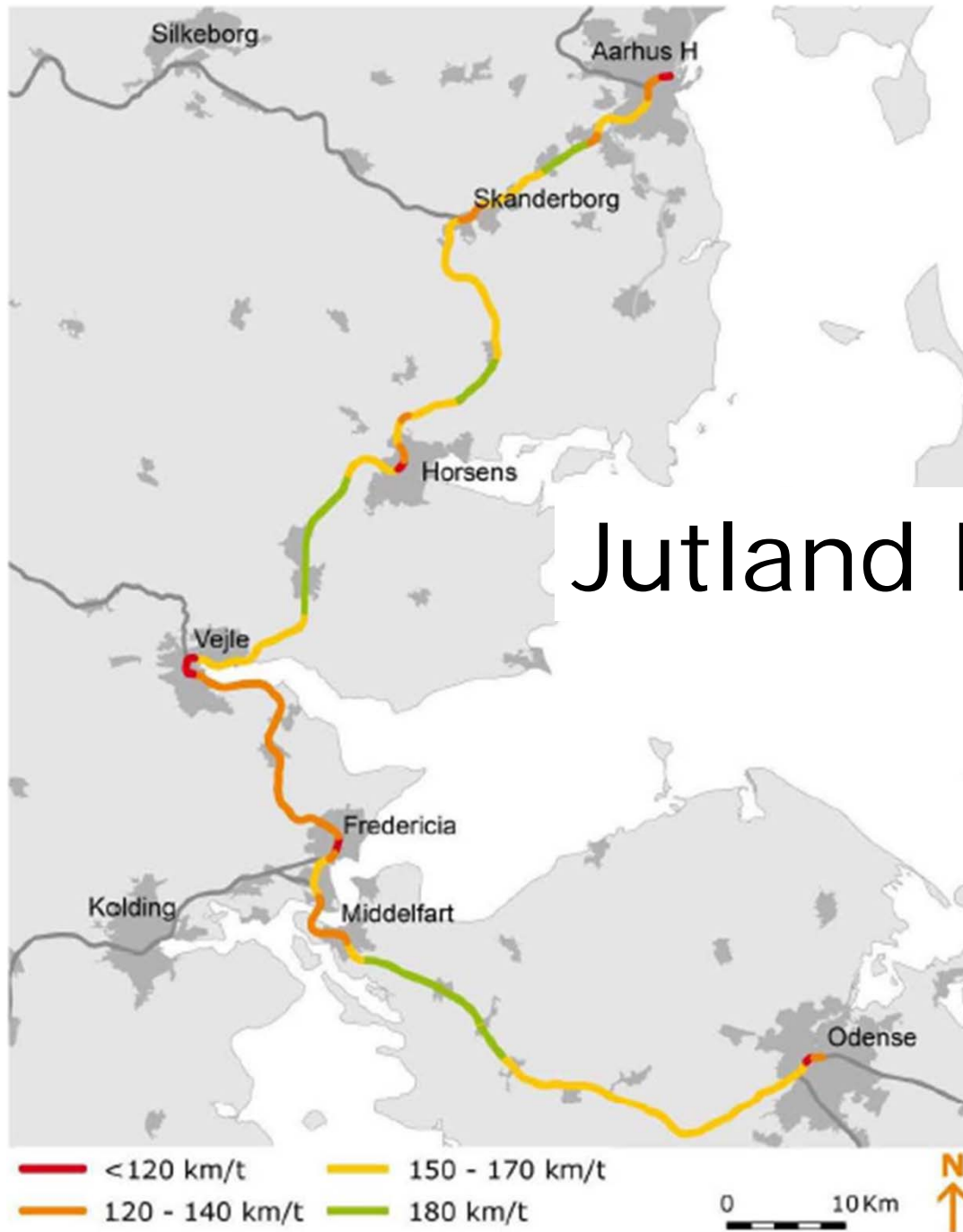
*Not a uniform network upgrade
Goal is NOT fastest train route*



Why One Hour?

- Trains from both directions arrive simultaneously
- Better connections to other services
- Similar to airline hub scheduling
- Less waiting time to/from bus, local rail

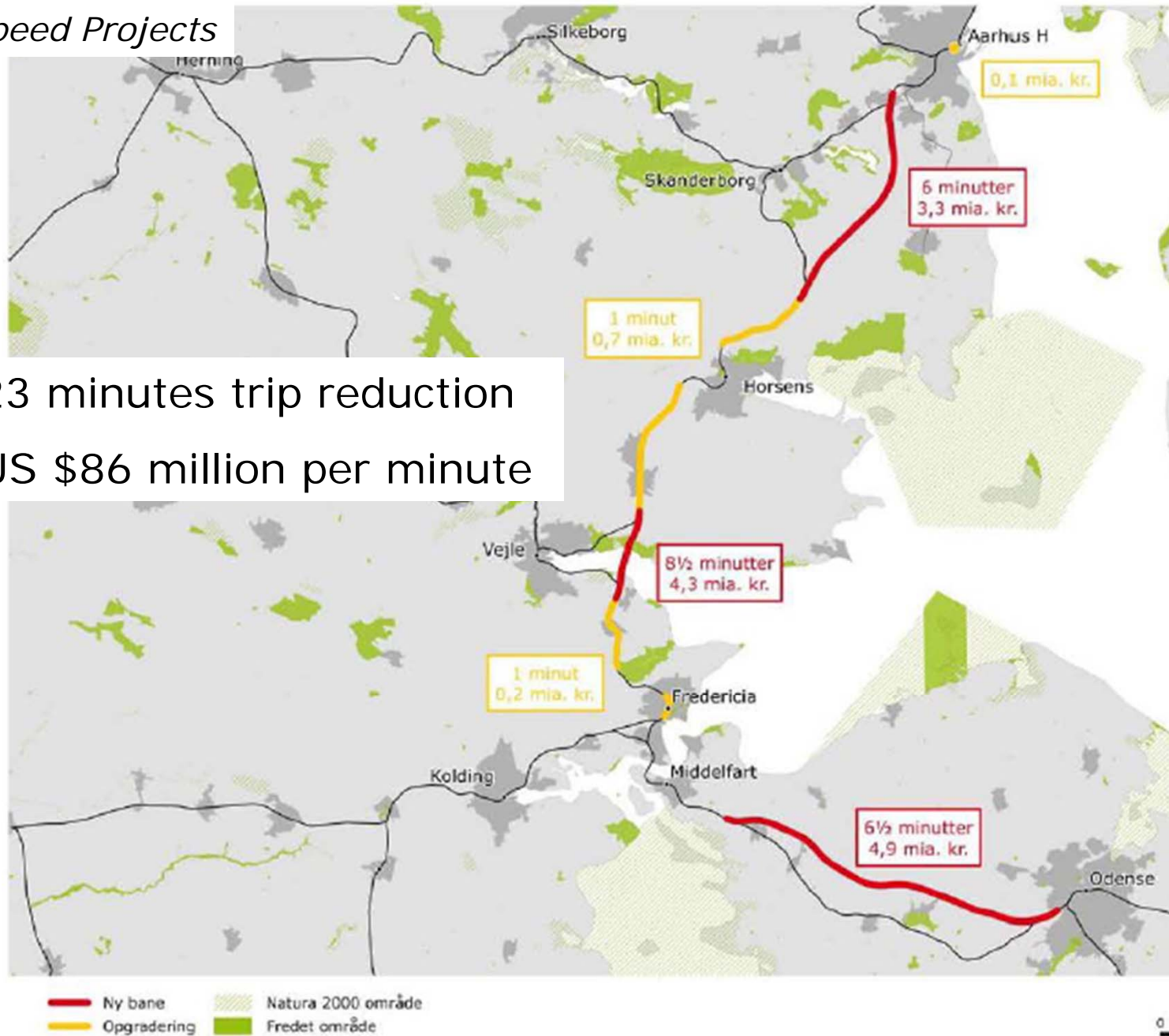




Jutland Main Today

Copenhagen →

High Speed Projects



- 23 minutes trip reduction
- US \$86 million per minute

Incremental Time Savings

Travel Time Odense-Aarhus	Diesel > IC3 180 kmh	IC4 200 kmh	Electric > ET 200 kmh	ICE 250 kmh	Velaro 300 kmh
Fastest Scheduled 2015	93 min				
Reduced timetable slack, 2016	87 min				
"" and non-stop trip	78 min	78 min	77 min	77 min	77 min
"" , "" , and high speed network	61 min	58 min	57 min	55 min	55 min

*IC3>>ICE; 78-55=23

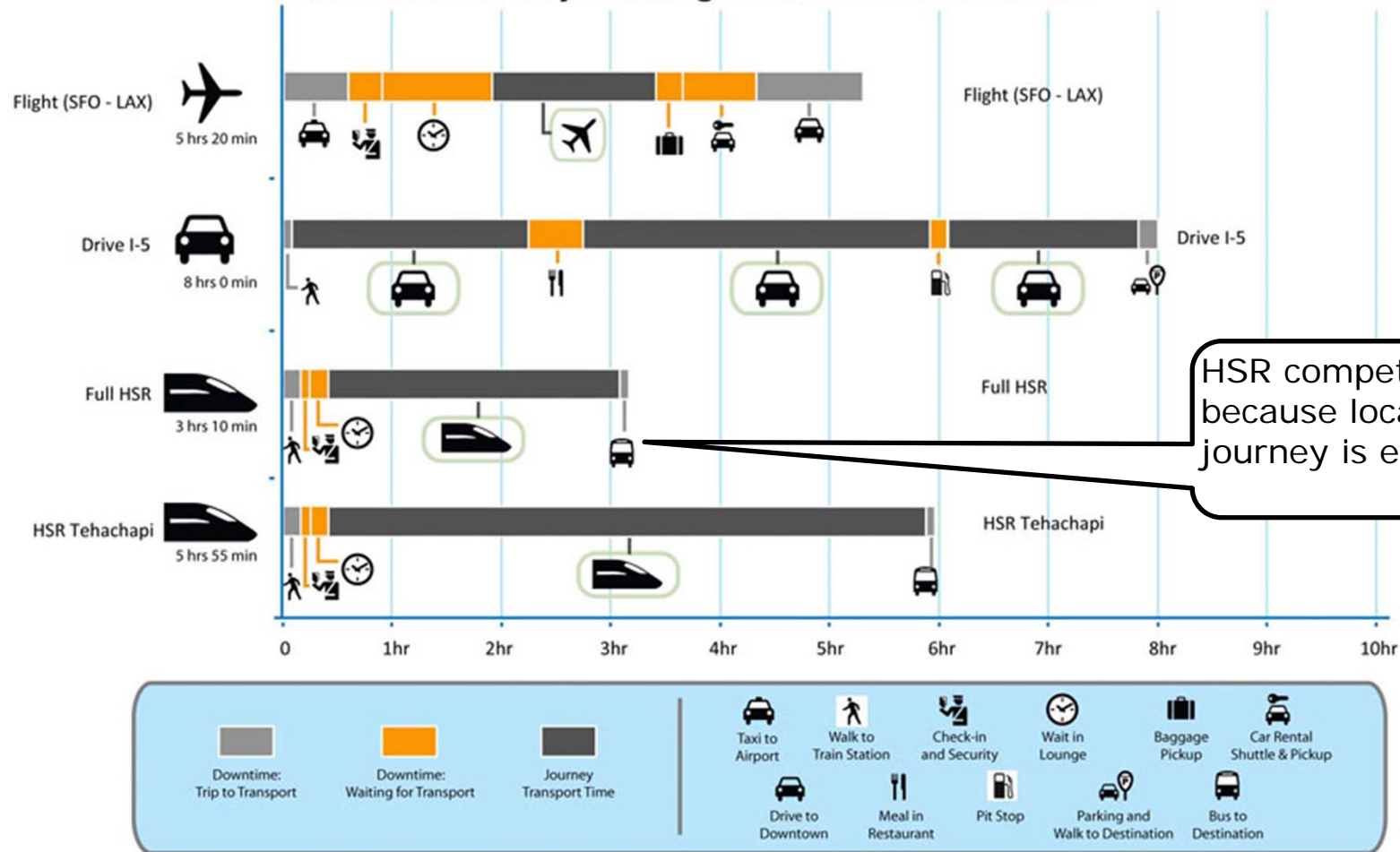
The Last Kilometer

- Often the Weak Link
- Coordination and Integration
- Large Scale Schedule Optimization
- Information for Riders
- Reliability and Robustness
 - Strong punctuality
 - Tools for response to failures
- Long Term: Grow Customers Near the System

Travel Time:

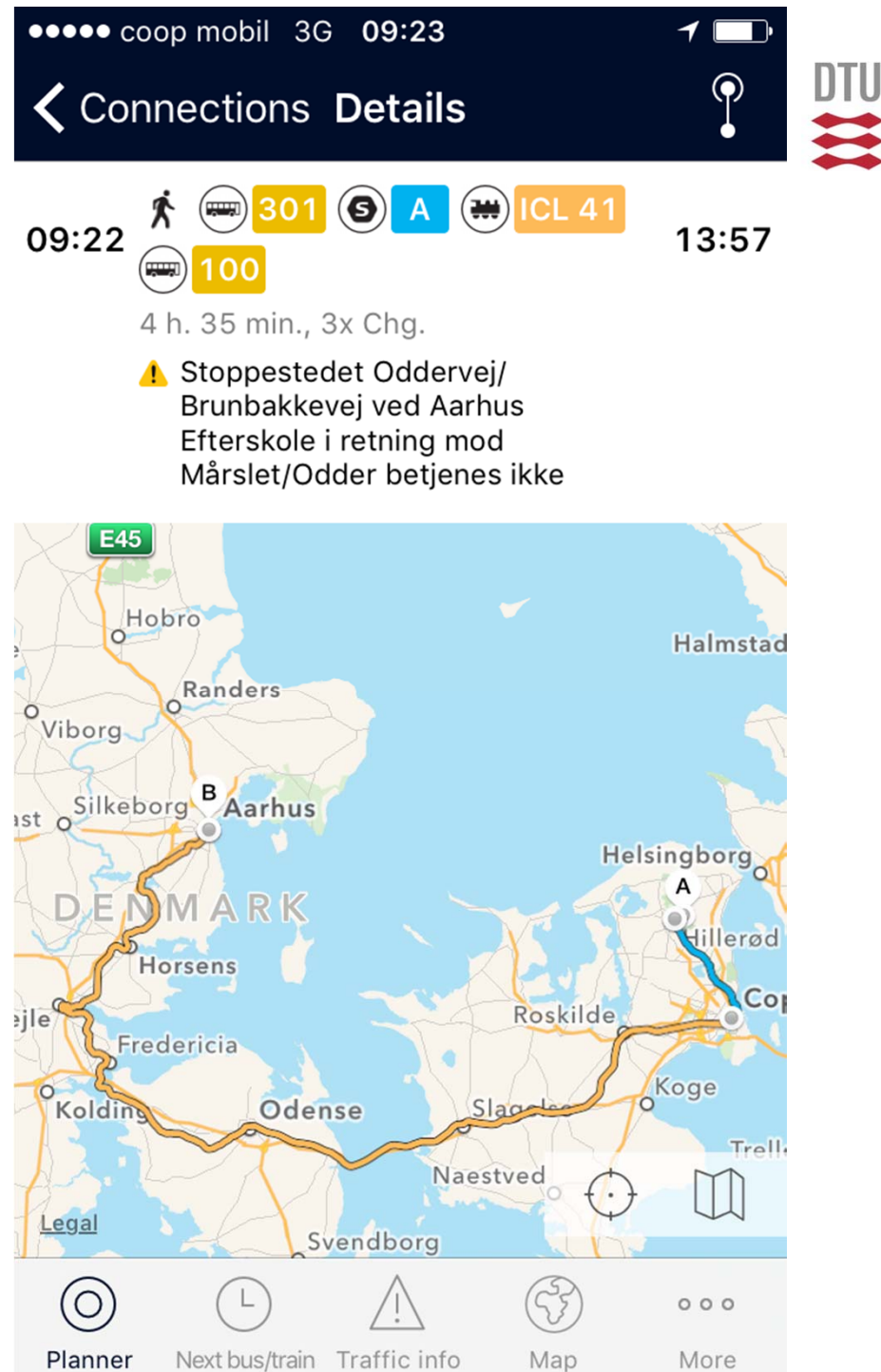
SAN FRANCISCO to LOS ANGELES

San Francisco Ferry Building to Grand Central Market



Seamless Journey From Origin to Destination

- 38% of this journey time is local travel
 - 170 min. intercity train
 - 105 min. transit connection
- HSR will *increase* this ratio
- Customer service focus shifts to local connections



Integration, Information

- Three Modes
 - Bus
 - Suburban
 - Intercity
- Four Providers
 - Movia
 - S-tog
 - DSB
 - Midttrafik
- Updated, Current

The screenshot shows the 'Connections Details' screen in the DTU Transport app. At the top, the status bar shows 'coop mobil E' and the time '09:22'. The app header has a back arrow and the title 'Connections Details'. The DTU logo is in the top right corner. The journey summary shows a start time of 09:22 and an end time of 13:57, with a duration of 4 h. 35 min. and 3 transfers. The route includes a walking segment, bus 301, S-tog (A), and bus ICL 41. A warning icon indicates a stoppage at Oddervej/Brunbakkevej ved Aarhus, with a note that the school is not served in this direction. Below the summary are icons for 'See price(s)', 'View on map', 'Share...urney', and 'Alarm'. The date 'Fri 23.10.2015' is displayed. The journey details are listed as follows:

Time	Location	Mode	Details
09:22	Smedievej 77, 3400 Hillerød, Hillerød Kommune	Walking	Walking route 453 m, 8 min. ✓
09:30	Smedievej	Bus 301	→ Ålholmparken 20 min., 17 Intermediate stops Cycle: 20 min. ✓
09:50	Hillerød St.	S-tog	

The bottom navigation bar includes icons for 'Planner', 'Next bus/train', 'Traffic info', 'Map', and 'More'.

Planning the København System

- The Players
 - DSB
 - Banedanmark
 - Movia
- Rail Sequence
 - DSB service design
 - Timetable agreement with Banedanmark
- Bus Sequence
 - Movia service design
 - Local subsidy agreement
 - Subcontract of bus routes

DSB Planning Cycle

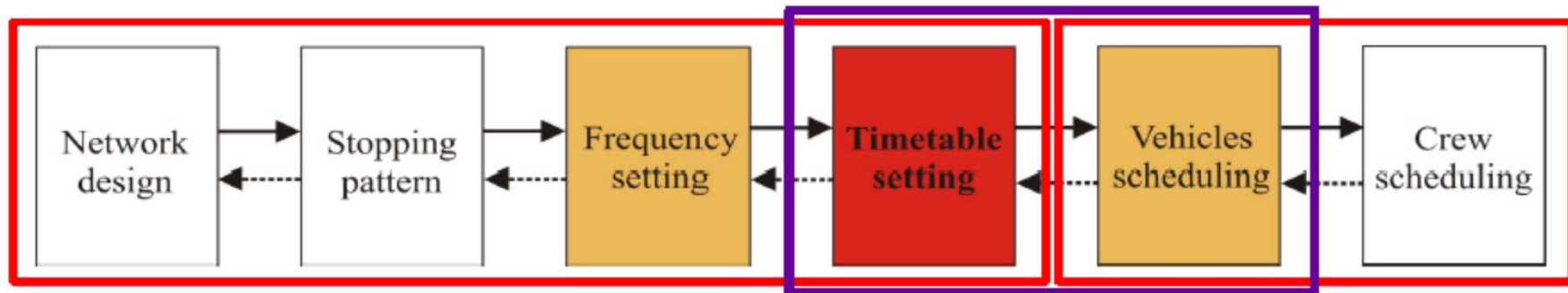


Integrated Timetable Challenges

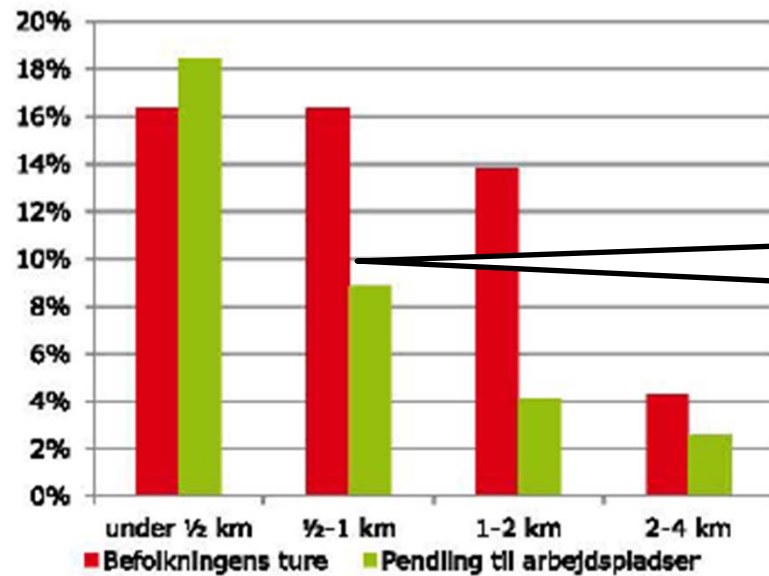
- DSB releases timetables less than six months from start date
- Movia negotiates bus contracts a year in advance
- Buses are also bound by local funding agreements
- Can be difficult to coordinate bus and rail with current mathematical models

Integrated Planning and Optimisation of Public Transport (IPTOP)

- Five Year Project: 2015-2019
- \$2.73 Million
- Danish "Innovationsfonden"
- Timetable Optimization and Simulation
 - Integrated across modes
 - Integrated across resources (rolling stock, crew)

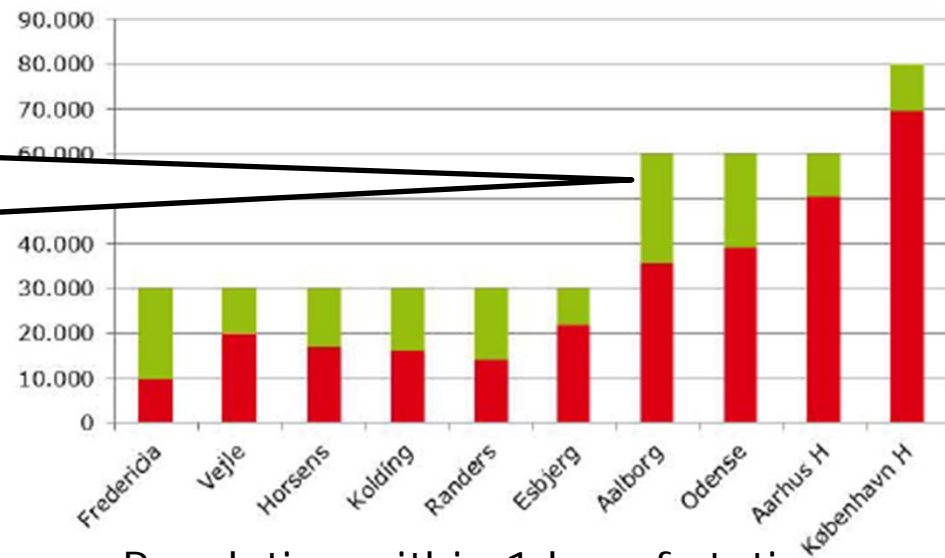


Land Use Planning



Customers closer to station more likely to use rail

Future land use policy (green) to double development near stations



Population within 1 km of station

Summary

- High speed rail is not a ground based airplane
- Strategic terminal/station locations and integrated local transit necessary
- Service design must be for a complete journey
- Long term, whole network planning saves money
- The high speed train is only part of the project

Thank You

